

ACTA POLYTECHNICA SCANDINAVICA

ANNOTATED INDEX 1982—1983

HELSINKI 1983

CONTENTS

Acta Polytechnica Scandinavica 1982	2
Acta Polytechnica Scandinavica 1983	3
Abstracts	4
Chemical Technology and Metallurgy Series	4
Civil Engineering and Building Construction Series	7
Electrical Engineering Series	8
Mathematics and Computer Science Series	9
Mechanical Engineering Series	12
Applied Physics Series	13
Author Index	16
Appendix A. Acta Polytechnica Scandinavica Ph 138, "Topics in Technical Physics", Contents	17
Appendix B. Acta Polytechnica Scandinavica E1 50, "Helsinki International Summer School on Semiconductors 1982", Contents	19

ACTA POLYTECHNICA SCANDINAVICA 1982

Ch Chemistry including Metallurgy

- Ch 148 Juhani Aittamaa: Computing Multicomponent Distillation
Ch 149 Juhani Aittamaa: Computational Methods for Distillation Design
Ch 150 Lennart Johansson, Bertil Törnell and Lennart Ågren: The Effect of Processing Conditions and Resin Structure on Impact Strength; Long — Term Performance and Fracture Morphology of Rigid PVC Pipes
Ch 151 Ilpo Silvennoinen and Seppo Palosaari: Drying of Water-Borne Coatings

Ci Civil Engineering and Building Construction

- Ci 81 Pertti Vakkilainen and Tuomo Karvonen: Adaptive Rainfall-Runoff Model, SATT-I

El Electrical Engineering

- El 49 Kari T. Jokela: Theory and Design of Narrow-Passband Stripline Filters with Finite Transmission Zeros Realized with Extra Cross Couplings

Ma Mathematics and Computer Science

- Ma 35 Jukka Ranta: On the Mathematical Modelling of Microbial Age Dynamic and Some Control Aspects of Microbial Growth Processes
Ma 36 Kauko Leiviskä: Short Term Production Scheduling of the Pulp Mill

Me Mechanical Engineering

- Me 82 Włodzimierz Tarnawski: An Analysis of Heat- and Moisture Movement in Soils in the Vicinity of Ground Heat Collectors for Use in Heat Pump Systems

Ph Applied Physics

- Ph 133 H. K. Collan, M. A. Kokkala and O. E. Toikka: Magnetic Filtration of Steel Mill Effluent Waters: Principles, Techniques, and Economics
Ph 134 Erkki Laurila and Risto Peltonen: A Microcomputer-Based Instrument for the Determination of Magnetic Content in Small-Sized Samples
Ph 135 Matti A. H. Leino, Pekka Pihkala and Erik Spring: A Device for Practical Determination of the Free Water Content of Snow

Index

Acta Polytechnica Scandinavica. Annotated Index 1980—1981

ACTA POLYTECHNICA SCANDINAVICA 1983

Ch Chemical Technology and Metallurgy (f. Chemistry including Metallurgy)

- Ch 152 K. Kontturi: Countercurrent Electrolysis in a Thin Porous Membrane
Ch 153 H. V. Nordén and L. M. Westerlund: An Accurate and Fast Method for Approximating Step and Impulse Responses

El Electrical Engineering

- El 50 T. Stubb (ed): Helsinki International Summer School on Semiconductors 1982
El 51 Heikki M. Isomäki: Electronic Structure of Anisotropic Semiconductors: Optical Properties and Behaviour under Hydrostatic Pressure

Ma Mathematics and Computer Science

- Ma 37 Martti Mäntylä: Computational Topology: A Study of Topological Manipulations and Interrogations in Computer Graphics and Geometric Modeling
Ma 38 E. S. Reuhkala: Recognition of Strings of Discrete Symbols with Special Application to Isolated Word Recognition
Ma 39 M. T. Hirvonen: Electromagnetic Field of an Oscillating Point Dipole in the Presence of Spherical Interfaces
Ma 40 S. Saukkonen: A Constructive Method for the Architectural Design and Correctness Verification of Real-Time Programs

Me Mechanical Engineering

- Me 83 Juhani von Boehm: Classical Doubly Anharmonic Oscillator
Me 84 M. J. Lampinen: Theory and Applications of a Multi-Circuit Heat Pump System

Ph Applied Physics

- Ph 136 Jouko Yli-Kauppila: Positron Experiments on Vacancies in Irradiated and Quenched Metals
Ph 137 Veli-Pekka Tanninen: X-ray Diffraction Studies of Aluminium Powder and Electroluminescent Zinc Sulphide Thin Films
Ph 138 V. Kelhä, M. Luukkala and T. Tuomi (eds): Topics in Technical Physics
Ph 139 J. Lammasniemi: A Vibrator Probe for Planting Position Sensing for a Tree Planting Machine
Ph 140 Runar Törnqvist: Electroluminescence in ZnS:Mn Thin Film Structures Grown with Atomic Layer Epitaxy

Index

Acta Polytechnica Scandinavica. Annotated Index 1982—1983

ABSTRACTS

CHEMICAL TECHNOLOGY AND METALLURGY SERIES

(former Chemistry including Metallurgy Series)

Ch 148

UDC 66.048

Aittamaa, J.: *Computing Multicomponent Distillation*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 148, Helsinki 1982, 29 pp. ISBN 951-666-145-9. ISSN 0001-6853.

Distillation columns are nowadays most often designed using a two-stage procedure. In the first stage the number of ideal plates required for the specific separation is calculated. This is often done by large computer programs which contain sophisticated models to describe the vapor-liquid equilibria and the enthalpies of the distillation mixture. In the second stage the real behavior of the plates is considered, i.e. plate efficiencies, pressure drops, entrainments etc. are taken into account and finally the column and the plate details are specified. These calculations are done manually with graphs or by separate computer programs.

In this paper a distillation column model is described. This model takes into account plate efficiencies, plate pressure drops and entrainments and thus the solution of this model will produce more realistic behavior of the distillation column. Methods of solving distillation models are discussed and a modification of the Newton-Raphson procedure is described.

Ch 149

UDC 66.048

Aittamaa, J.: *Computational Methods for Distillation Design*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 149, Helsinki 1982, 24 pp. ISBN 951-666-150-5. ISSN 0001-6853.

This thesis is based on seven different publications concerning binary and multicomponent distillation.

In the first part the vapor-liquid equilibria (VLE) and the methods to obtain the parameters of the activity coefficient models of the distillation mixture are discussed.

Computation schemes for multicomponent distillation are also discussed and a distillation model is presented. This model takes into account plate efficiencies, plate pressure drops and entrainments, features of real distillation columns which are not generally included in mathematical models. The inclusion of these phenomena makes the solution of the column equation more difficult but the solution of the model is more realistic. The model is solved using a modification of the Newton-Raphson procedure, which proves to be reliable. The model compares well with experimental results from small columns.

A rigorous dynamic model for the water/ethanol distillation column at Helsinki University of Technology is described and tested.

Finally the simplification of linear state-space models of distillation is studied using the method of moments.

Ch 150

UDC 678.743:620.187

Johansson, L., Törnell, B., and Ågren, L.: *The Effect of Processing Conditions and Resin Structure on Impact Strength; Long-Term Performance and Fracture Morphology of Rigid PVC Pipes*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 150, Helsinki 1982, 24 pp. ISBN 951-666-154-8. ISSN 0001-6853.

Rigid PVC pipes were prepared from four commercial suspension PVC resins of equal K-values, using four different double screw extruders. For each resin-extruder combination a set of compounds with different lubricant contents was run in order to vary the level of gelation. The experiments were carried out in order to study the possible effect of resin structure and processing conditions on the quality of the pipes.

The falling weight impact strength of the pipes was found to depend on the choice of resin. An increase in the amount of lubricant resulted in a decrease in the resistance to internal pressure.

The fractographic investigation by light and scanning electron microscopy revealed that the large variation observed in the time-to-failure was partly a result of the different modes of failure. In the present study, the main cause of fracture initiation seemed to be the presence of pigment agglomerates within the pipe wall. In some cases the fracture occurred via semi-elliptical surface cracks, indicating that the fracture was probably initiated by notches or by regions of bad gelation.

Ch 151

UDC 66.047.3:667.663.22

Silventoinen, I., Palosaari, S.: *Drying of Water-Borne Coatings*. Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 151, Helsinki 1982, 22 pp. ISBN 951-666-153-X. ISSN 0001-6853.

A method for calculation of the drying time and of the surface temperature is presented for convective and infra-red drying of water-borne coatings. This is made by deriving the energy balance for the paint film and solving the equation numerically.

The used approach is based on the van Meel equation where the contributions by the drying properties of the material, the mass transfer rate to the surrounding air, and the drying potential of the surrounding air are all separated into different terms. The drying properties of the material are given as an experimental relative drying rate curve at one temperature. The calculated drying history of the paint film is verified by experimental results.

Ch 152

UDC 541.133.1

Kontturi, K.: *Countercurrent Electrolysis in a Thin Porous Membrane*, Acta Polytechnica Scandinavica, Chemistry including Metallurgy Series No. 152, Helsinki 1983, 40 pp. ISBN 951-666-160-2. ISSN 0001-6853.

Countercurrent electrolysis is a method used to separate ions from their mixtures. In this thesis it is shown that modifying the countercurrent electrolysis so that it takes place in a system that consists of a thin porous membrane instead of earlier used long capillaries, packed columns, etc. notable advantages can be gained. The process becomes continuous, faster, and large amounts of solutions can be treated.

This thesis is based on seven different publications and a monograph concerning the transport of electrolyte solution across the membrane.

Because of the essential role of mathematical modelling the solution of Nernst-Planck equations used to describe the transport in the porous membrane are studied at first. Since these equations are approximate, comparison with experiments and better transport equations is used to examine how good the approximation is. The suitability of Nernst-Planck equation was found to be reasonably good.

Finally, the countercurrent electrolysis in a thin porous membrane is studied both theoretically and experimentally.

Nordén, H. V., Westerlund, L. M.: *An Accurate and Fast Method for Approximating Step and Impulse Responses*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 153, Helsinki 1983, 46 pp. ISBN 951-666-172-6. ISSN 0001-6853.

A simple approximation method based on limit value is presented and applied to linearized problems of process dynamics in distillation and absorption. The matrix function $\exp(At)$, which is needed in the calculation of step and impulse responses, is approximated. Mathematical error analysis is included. The method presented here is compared with two approximation methods in which the response of the original model is approximated by the response of the reduced model. A comparison is made of both accuracy of approximation and time of calculation.

CIVIL ENGINEERING AND BUILDING CONSTRUCTION SERIES

Ci 81

UDC 556.16:519.876.5

Vakkilainen, P. and Karvonen, T.: *Adaptive Rainfall-Runoff Model, SATT-I*. Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 81, Helsinki 1982, 54 pp. ISBN 951-666-151-3. ISSN 0355-2705.

The rainfall-runoff model SATT-I is introduced. In the model soil moisture can be treated in a physically based or in a conceptual way. Similarly, flood routing can be calculated either by using St. Venant's equations or by using the Muskingum method. The latter is also used in the timing of direct runoff. The regulation routines for lakes and reservoirs are versatile and applicable to all practical cases. The model has 10 calibrable parameters whose values can be searched with an automatic calibration using the simplex algorithm. The model is provided with an adaptive calibration system which improves the accuracy of forecasts as new data are available. After presentation of the model some practical applications to the Kyrönjoki river basin in Western Finland are given.

ELECTRICAL ENGINEERING SERIES

EI 49

UDC 621.372.543:621.3.029.6

Jokela, K. T.: *Theory and Design of Narrow-Passband Stripline Filters with Finite Transmission Zeros Realized with Extra Cross Couplings*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 49, Helsinki 1982, 89 pp. ISBN 951-666-155-6. ISSN 0001-6845.

In this work narrow-passband microwave filters consisting of coupled stripline resonators are studied. Extra cross couplings between resonators are utilized to create finite transmission zeros. The design is based on a capacitance inverter low-pass prototype filter. Some of the most useful available synthesis methods for the prototype are first reviewed and approximate design equations for a network having single imaginary-axis and real-axis zero pairs are then derived. A novel planar stripline filter structure was developed. The filter consists of capacitively coupled half-wave stripline resonators, extra cross couplings between the resonator chains being inductive. Also generalized interdigital filters using a multilayer stripline structure were constructed. Finally, a simple approximative loss analysis method for homogeneous uniform coupled TEM-lines is considered and the presented loss model is applied to generalized interdigital filters.

EI 50

UDC 621.315.59

Helsinki International Summer School on Semiconductors 1982. Proceedings of Helsinki International Summer School on Semiconductors, Espoo, Finland, 14—18 June 1982. Edited by Tor Stubb. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 50, Helsinki 1983, IX + 450 pp. ISBN 951-666-167-X. ISSN 0001-6845.

(Contents, see App. B)

EI 51

UDC 538.956/.958:53.092
538.915

Isomäki, Heikki M.: *Electronic Structure of Anisotropic Semiconductors: Optical Properties and Behaviour under Hydrostatic Pressure*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 51, Helsinki 1983, 15 pp. ISBN 951-666-168-8. ISSN 0001-6845.

The results of 14 inquiries into the electronic properties of trigonal Se and Te and hexagonal TiS_2 , TiSe_2 , ZrS_2 and ZrSe_2 are summarised in this paper. The ab initio energy bands (calculated by using the local exchange-correlation potential) are obtained with the use of the self-consistent orthogonalised-plane-wave (OPW) method. In Se the indirect minimum energy gap $M \rightarrow H$ changes to the direct one $H \rightarrow H$ at around 35 kbar accounting for the anomaly found in the experimental absorption edge. In Te the pressure dependence of the energy gaps indicates that the absorption edge for both polarisations of light is due to direct transitions at corner point H. The minimum energy gap of Te closes at around 38 kbar. The relativistic corrections (calculated by using the full relativistic part of the Foldy-Wouthuysen Hamiltonian as the perturbation operator) diminish the p-p energy gaps of the chalcogens but increase the p-d energy gaps of the dichalcogenides. For Se the calculation distinctly differs from the interpretation based on the recent photoluminescence measurement. The relativistic corrections are essential for calculating the transport properties of Te. Differences between the results of the calculation and the experimental $\vec{k} \cdot \vec{p}$ band models (the mass-velocity and Darwin terms neglected) are found. A rigorous derivation of the one-electron permittivity tensor for noncubic semiconductors is given. The permittivity, reflectivity, absorption coefficient and electron-energy-loss function are calculated for Se, Te, ZrS_2 and ZrSe_2 with the use of the rigorously evaluated momentum matrix elements. The local-field effects are estimated to be small which contradicts the recent model studies for Se and Te. The corrections needed for even closer agreement with experiments should be opposite to and smaller than the local-field and continuum-excitation corrections calculated recently for C, Si and TiCl_3 . The reasons for the differences in the ultraviolet region between the calculated one-electron spectra and the experimental ones of Si, Ge, GaP, GaAs, InAs, InSb, ZnS and ZnSe are discussed with reference to the present results.

MATHEMATICS AND COMPUTER SCIENCE SERIES

Ma 35

UDC 576.8.095:519.2

Ranta, J.: *On the Mathematical Modelling of Microbial Age Dynamic and Some Control Aspects of Microbial Growth Processes*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 35, Helsinki 1982, 108 pp. ISBN 951-666-147-5. ISSN 0355-2713.

In this work biomass age dynamic and control aspects of microbial growth processes were studied. A dynamical model for biomass age distribution was formed, and the solution forms of that equation were presented. It was shown that the age distribution model can be converted to a system, governed by the positive feedback and described by a Volterra type integral equation. From the asymptotical properties of the Volterra equation stability properties of the age distribution can be concluded. It was shown that the original equation can be transferred into a discrete time discrete age presentation which corresponds to Leslie-matrix population model. Applying the properties of Leslie-matrix and the harvesting theory basic stability and controllability properties of the age distribution can be concluded in the timeinvariant case. The extension of studies to the timevariant case leads to a bilinear system. The basic control strategies for the bilinear system were formed. Finally application remarks of the age distribution, like estimation of the growth activity of the biomass and final product formation with the help of age distribution, are presented.

Ma 36

UDC 676.012:658.513:681.5.015

Leiviskä, K.: *Short Term Production Scheduling of the Pulp Mill*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 36, Helsinki 1982, 80 pp. ISBN 951-666-152-1. ISSN 0355-2713.

Pulp mill production scheduling must provide the operational staff with production schedules calculated for a period of 2—5 days. In scheduling, the capacity of the processes and the constraining storage capacity must be taken into account.

In this monograph, a new method for the computerized production scheduling in pulp mills is introduced. The method is based on a well-known hierarchical optimization algorithm, Tamura's algorithm for time delay systems. The modifications and application aspects of this algorithm are presented together with a representative number of examples.

This method provides a straightforward and computationally simple approach to pulp mill production scheduling. In any case, the most important aspects which are practically interesting can be included in this method. As shown in the text, it can be easily extended to mills with multiple production lines and in fact for any degree of complexity in flow connections.

Mäntylä, Martti: *Computational Topology: A Study of Topological Manipulations and Interrogations in Computer Graphics and Geometric Modeling*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 37, Helsinki 1983, 49 pp. ISBN 951-666-161-0. ISSN 0355-2713.

The extent to which computer-aided design systems can support the design process depends on the completeness and accuracy of their geometric models. We introduce the term "computational topology" to denote the study of data structures and algorithms dealing with the topological aspects of these models.

We derive a collection of basic topological manipulation operations, the so-called Euler operators, and show that they naturally correspond to a useful class of physical objects.

Many problems of importance can be solved by algorithms based on Euler operators. These include (1) topological analysis, i.e. calculation of global topological properties from local ones, and (2) the topological manipulations of a set operation algorithm.

The ideas and algorithms have been demonstrated in an operational software system developed by the author.

Reuhkala, E. S.: *Recognition of Strings of Discrete Symbols with Special Application to Isolated Word Recognition*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 38, Espoo 1983, 92 pp. ISBN 951-666-163-7. ISSN 0355-2713.

This thesis is based on seven different publications on the recognition of patterns that are represented as strings of discrete symbols. The most common examples of patterns of this kind are words and names of natural languages that are usually represented as character strings in computers. New methods are developed for the efficient solution of this recognition problem. Different variants of the new methods are applied to automatic spelling correction and isolated word recognition. There are also numerous other possible areas of application. The search for candidate strings containing similar substrings or features with the unknown string is based on Kohonen's Redundant Hash Addressing principle. The recognition of the strings is based on feature-based distance measures developed in this thesis. In the application to spelling correction the new methods are up to 80 times more efficient than the methods based on Levenshtein Distances. In the application to isolated word recognition, the number of recognition errors is about 40 per cent smaller than the previous best results.

Hirvonen, M. T.: *Electromagnetic Field of an Oscillating Point Dipole in the Presence of Spherical Interfaces*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 39, Helsinki 1983, 37 pp. ISBN 951-666-164-5. ISSN 0355-2713.

The electromagnetic field of a sinusoidally oscillating electric or magnetic point dipole is calculated in the presence of spherical inhomogeneities. An analytical series solution of the Helmholtz equation in a space containing one sphere is first derived on the basis of the spherical wave expansion of the retarded vector potential of a dipole. The solution is completely general with respect to the frequency and the values of the constant permittivity, permeability and conductivity of the sphere and its surroundings. A system of two concentric spheres is next treated in a similar way. Finally, an analytical formula for the translatory transformation of the vector wave functions is applied to derive a precise solution to the problem of the scattering of dipolar waves from a system of two nonconcentric spheres. A number of numerical examples chosen to represent practical situations in geophysical mineral exploration are given.

Saukkonen, S.: *A Constructive Method for the Architectural Design and Correctness Verification of Real-Time Programs*. Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 40, Helsinki 1983, 122 pp. ISBN 951-666-170-X. ISSN 0355-2713.

During the architectural design of a real-time program, its correct behaviour can be verified by using a proposed new method based on the theory of place transition nets and timed place transition nets. Program architecture is described in stepwise refinements by using the proposed SSL (Software Structure Language) descriptions for the static part of the architecture and the proposed OBL (Object Behaviour Language) descriptions for the dynamic behaviour of the program. The correctness of the specified communication behaviour between the processes and the absence of deadlocks will be verified. The absence of livelocks and infinite loops cannot be verified in general at the architectural design level. However, their possibility and cause can be detected. The timing verification of the communication behaviour, necessary owing to the real-timeness, will also be made. The verifications can be made constructively in parallel to the architectural design. The practicality of the proposed design description and verification method is demonstrated by an application to a medium scale real-time program.

MECHANICAL ENGINEERING SERIES

Me 82

UDC 550.36:662.99:621.577

Włodzimierz Tarnawski: *An Analysis of Heat- and Moisture Movement in Soils in the Vicinity of Ground Heat Collectors for Use in Heat Pump Systems*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 82, Helsinki 1982, 187 pp. ISBN 951-666-156-4. ISSN 0001-687X.

A numerical analysis has been made of coupled heat and moisture flow in soils, adjacent to a horizontal ground heat collector. The one dimensional mathematical model includes the phase change phenomenon and heat and moisture exchange at the ground surface with respect to meteorological data such as solar radiation, cloudiness, ambient temperature, wind velocity, precipitation, water vapor pressure, depth of snow cover and its density, albedo etc. The phase change is treated as an isothermal process. The solution of the mathematical model was based on a finite difference formulation and the three time level scheme. The validity of the numerical solution was determined by a comparison of the simulated and experimental field data for the case without heat extraction. Results obtained show good agreement. Numerical computations carried out for Finnish conditions and the case with heat extraction lead to the following conclusions: heat collectors should be situated as near the ground surface as it is possible, specific heat extraction should be about 10 W/m² and even less to avoid ecological risk, moisture movement in soils can be disregarded for practical use.

Me 83

UDC 531.32

von Boehm, Juhani: *Classical Doubly Anharmonic Oscillator*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 83, Helsinki 1983, 27 pp. ISBN 951-666-171-8. ISSN 0001-687X.

The motion of the classical doubly anharmonic oscillator having the (dimensionless) equation of motion $\ddot{u} + 2\zeta\dot{u} + u - \alpha u^2 + \beta u^3 = f \cos(\Omega\tau)$ is studied. Free oscillations ($f=0$) without ($\zeta=0$) and with ($\zeta \neq 0$) damping as well as forced oscillations ($f \neq 0$) without damping ($\zeta=0$) are considered. The 1/5 subharmonic, in the forced undamped case, is also considered. The character of the free damped motion is determined by the three stable spiral points (or nodes) and the two saddle points, spaced symmetrically along the u -axis in the u - \dot{u} phase plane. The amplitude - Ω^2 response diagram of the forced oscillations has 1-2 jumps with increasing Ω^2 (depending on parameters) and 2 jumps with decreasing Ω^2 .

Me 84

UDC 536.7:621.577.674.04, 697.34

Lampinen, M. J.: *Theory and Applications of a Multi-Circuit Heat Pump System*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 84, Helsinki 1983, 48 pp. ISBN 951-666-166-1. ISSN 0001-687X.

A multi-circuit heat pump system consists of several heat pump units which are connected in counterflow in respect to the waste heat and heat-receiving mass flows. A general theory of the multi-circuit heat pump system is presented here.

The larger the number of the heat pump circuit applied, the higher is the coefficient of performance. The dividing of the steps among the different circuits also affects the coefficient of performance. As is shown here, the best result is achieved when the absolute temperature of the heat-receiving mass flow form a geometric series.

Three practical applications of multi-circuit heat pump systems are presented. Two of them involve heat transfer from water to water and the third one concerns a four-circuit heat pump dehumidifier in timber drying. The results of measurements concerning these applications are presented as well as the detailed technical description of each of them.

APPLIED PHYSICS SERIES

Ph 133

UDC 628.33

Collan, H. K., Kokkala, M. A., and Toikka, O. E.: *Magnetic Filtration of Steel Mill Effluent Waters: Principles, Techniques, and Economics*. Acta Polytechnica Scandinavica, Applied Physics Series No. 133, Helsinki 1982, 61 pp. ISBN 951-666-146-7. ISSN 0355-2721.

The basic physical, technical, and economical principles of magnetic filtration are described. The theory of deep-bed filtration is employed when dimensioning an optimum filter for a water treatment process. Magnetic filtration of nine different kinds of waste waters appearing in the Finnish steel industry is discussed. The economical estimates based on experimental results show that magnetic filtration is a suitable method especially in those applications, where the water contains at least partly ferromagnetic and small ($< 10 \mu\text{m}$) particles, and where the concentration is low ($< 500 \text{ mg/l}$). Such waters are, for example, the scale pit overflow waters in hot rolling processes and the gas washing water of an oxygen converter. The estimates suggest that magnetic filtration could be economically applied in half a dozen waste water treatment processes in the Finnish steel industry. An example of a water treatment process plan is described.

Ph 134

UDC 621.317.4:621.318:622.341

Laurila, Erkki and Peltonen, Risto: *A Microcomputer-Based Instrument for the Determination of Magnetite Content in Small-Sized Samples*. Acta Polytechnica Scandinavica, Applied Physics Series No. 134, Espoo 1982, 30 pp. ISBN 951-666-148-3. ISSN 0355-2721.

The construction of an instrument for the determination of magnetite content in powdered samples is presented. The percentage is measured automatically by weighing the sample successively in the known magnetic field and in zero field. The magnetic field which is strong enough to saturate the sample is generated by SmCo_5 magnets. A new design principle was applied to the support of the balance. The bearings are based on the magnetic levitation with the feedback coupled to the supporting magnets. The functions of the instrument are controlled, and the results are processed by a single board microcomputer. The weight of the sample is approximately 3 g, and the practical accuracy of the instrument is 0.5% or 5 mg. The analysis takes about 15 seconds.

Ph 135

UDC 551.322:531.43

Matti A. H. Leino, Pekka Pihkala and Erik Spring: *A Device for Practical Determination of the Free Water Content of Snow*. Acta Polytechnica Scandinavica, Applied Physics Series No. 135, Helsinki 1982, 12 pp. ISBN 951-666-157-2. ISSN 0355-2721.

A device — a dilatometer — for determination of the free water content of snow has been developed. The method is based on the volume decrease of snow on melting. A single determination takes about 15 min and has an accuracy of $\pm 1.5 \%$ -units.

Yli-Kauppi, Jouko.: *Positron Experiments on Vacancies in Irradiated and Quenched Metals*. Acta Polytechnica Scandinavica, Applied Physics Series No. 136, Helsinki 1983, 33 p. ISBN 951-666-158-0. ISSN 0355-2721.

This thesis is based on seven different publications dealing with positron studies of vacancy-type defects and their interactions in metals. The great advantage of the positron method is its defect specificity. It is sensitive only to open-volume defects and can reveal their clustering in the size range where the clusters are invisible by any other methods.

In this work vacancy properties in iron and niobium are discussed on the basis of isochronal annealing experiments carried out after low temperature electron and neutron irradiations. The results strongly support the vacancy model to explain the stage III recovery in metals. In addition, irradiation damage in various amorphous alloys is studied. It is revealed for the first time that vacancy-type defects are created by low temperature irradiations also in these metals. Finally, positrons are applied in investigating the behavior of vacancies in age-hardenable Al alloys. Quenched-in vacancies are observed to be in the form of vacancy-solute atom complexes. Their concentration decreases simultaneously with the growth of GP zones.

Tanninen, Veli-Pekka: *X-ray Diffraction Studies of Aluminium Powder and Electroluminescent Zinc Sulphide Thin Films*. Acta Polytechnica Scandinavica, Applied Physics Series No. 137, Helsinki 1983, 33 pp. ISBN 951-666-162-9. ISSN 0355-2721.

This thesis consists of three topics in six different publications mainly in the field of x-ray diffraction. Some studies of luminescence spectroscopy are also included. The atomic scattering factors of aluminium were determined for the first time by low temperature (80 K) x-ray diffraction. The second publication presented an experimental method of high ability monochromatization.

The main topic of the thesis is the subject of the four publications dealing with structural characterization of manganese doped zinc sulphide (ZnS:Mn) thin films which are used as electroluminescent (EL) display panels. Such microstructural parameters as crystal phase, preferred orientation, crystallite size, relative microstrain and dislocation density are studied as a function of essential crystal growth parameters (growth temperature, film thickness, substrate material). Analyses showed that the films grown by the atomic layer epitaxy (ALE) method developed in Finland have exceptionally uniform crystalline properties.

Kelhä, V., Luukkala, M. and Tuomi, T. (eds.): *Topics in Technical Physics*. Acta Polytechnica Scandinavica, Applied Physics Series No. 138, Helsinki 1983, 180 pp. ISBN 951-666-159-9. ISSN 0355-2721.

A special issue of Acta Polytechnica Scandinavica dedicated to Professor *Erkki Laurila*, Member of the Academy of Finland, on the occasion of his 70th birthday August 20, 1983 and in honour of his scientific work. Technical physics is here considered in its broadest sense, including in addition to physics and the technical sciences also mathematics, information science and economics.

(Contents, see App. A)

Lammasniemi, J.: *A Vibrator Probe for Planting Position Sensing for a Tree Planting Machine*. Acta Polytechnica Scandinavica, Applied Physics Series No. 139, Helsinki 1983, 90 pp. ISBN 951-666-165-3. ISSN 0355-2721.

This report presents the theory, development and construction of a vibrator probe to sense the planting position for an automatic tree planting machine. The probe is based on a rugged mechanical vibrator which is slid along the soil surface. The vibration frequency is 40 Hz, the mass of the vibrator is 3.5 kg and the surface contact area is 100 cm². The vibrator loading, especially the nonlinearity of it, is dependent on the mechanical properties of the sensed surface. This causes large variations in the waveform of the vertical vibration acceleration. The correlation between the signal waveform and the type of sensed surface is used for surface recognition. The acceleration signal is analyzed in a three channel parallel real time frequency analyzer, together with channel level detectors. The decision, whether the sensed surface point is acceptable for planting or not, is made in a logic circuitry combining the channel data.

The probe has been applied to a continuously advancing intermittent tree planting machine. In an experiment using the sensor system to control the planting work in uneven terrain with plenty of logging slash, the share of the plantings made in mineral soil was increased from 56% without the sensor to 80% with the sensor. Similarly, the percentage of plants falling in logging slash, vegetative layers and obstacles was decreased from 18% to 4%.

Törnqvist, Runar: *Electroluminescence in ZnS:Mn Thin Film Structures Grown with Atomic Layer Epitaxy*. Acta Polytechnica Scandinavica, Applied Physics Series No. 140, Helsinki 1983, 34 pp. ISBN 951-666-169-6. ISSN 0355-2721.

This thesis is based on seven publications dealing with electroluminescence in ZnS:Mn thin film structures grown with Atomic Layer Epitaxy. Particular emphasis has been given to the excitation and the relaxation processes of the light emitting Mn²⁺ centre. Estimations indicate that under operation conditions most of the conduction electrons in the ZnS:Mn layer have a kinetic energy sufficient for impact excitation of the Mn²⁺ centre, and that threshold voltage for the onset of the emission reflects rather free electron generation than the acceleration of electrons up to optical energies. A saturation in the light emission is suggested to arise from an interaction between excited Mn²⁺ centres resulting in nonradiative decay. The experimental results also indicate that the interaction occurs by energy transfer via unexcited Mn²⁺ ions. The aging behaviour of the ZnS:Mn electroluminescence thin film structures is explained in terms of electron trapping at the ZnS:Mn-insulator interfaces. The unique crystalline properties of ZnS:Mn films grown with Atomic Layer Epitaxy are indicated by the presence of fine structure in the emission and the excitation spectra of the Mn²⁺ centre, and by a thin dead layer in the ZnS:Mn film.

AUTHOR INDEX

	Page
Aittamaa, J.	4
von Boehm, J.	12
Collan, H. K.	13
Hirvonen, M. T.	10
Isomäki, H. M.	8
Johansson, L.	5
Jokela, K. T.	8
Karvonen, T.	7
Kelhä, V. (ed.)	14
Kokkala, M. A.	13
Kontturi, K.	5
Lämmaneniemi, J.	15
Lampinen, M. J.	12
Laurila, E.	13
Leino, M. A. H.	13
Leiviskä, K.	9
Luukkala, M. (ed.)	14
Mäntylä, M.	10
Nordén, H. V.	6
Palosaari, S.	5
Peltonen, R.	13
Pihkala, P.	13
Ranta, J.	9
Reuhkala, E. S.	10
Saukkonen, S.	11
Silventoinen, I.	5
Spring, E.	13
Stubb, T. (ed)	8
Tanninen, V.-P.	14
Tarnawski, W.	12
Toikka, O. E.	13
Tuomi, T. (ed)	14
Törnelli, B.	5
Törnqvist, R.	15
Vakkilainen, P.	7
Westerlund, L. M.	6
Yli-Kauppila, J.	14
Ågren, L.	5

APPENDIX A

ACTA POLYTECHNICA SCANDINAVICA Ph 138, "Topics in Technical Physics"

CONTENTS

Preface, *Väinö Kelhä, Mauri Luukkala, and Turkka Tuomi*

Erkki Aukusti Laurila, *Pekka Jauho*

Bygone years at Helsinki University of Technology, *M. H. Tikkanen*

Analytical methods for the design calculation of permanent-magnet synchronous couplings, *Werner Baran*

Superconducting magnet applications in Finland, *P. Berglund, H. K. Collan, and O. V. Lounasmaa*

Polynomial systems theory and multivariable feedback compensator design, *Hans Blomberg, Raimo Ylinen, and Pauli Sipari*

Laser scanning and recording systems, *Eero Byckling*

Linear conductance of very short semiconductor samples, *S. Eränen, J. Sinkkonen, and T. Stubb*

The mass receptor potential in the study of enzymatic processes in the vertebrate retinal photoreceptors, *Simo Hemilä*

Inversion of geophysical electromagnetic measurements, limitations and approximate solutions, *Sven-Erik Hjelt*

A probabilistic model for spent fuel management costs, *Pekka Jauho*

REWET-II facility for experiments on the loss-of-coolant accident in nuclear reactors, *Heikki Kalli, Timo Kervinen, and Anitta Hämäläinen*

A new magnetic method for studying the quality of lung-retained dust *in vivo*, *K. Kalliomäki, P-L. Kalliomäki, and M. Moilanen*

The influence of magnetization on eddy current inspection of ferromagnetic tubes, *V. Kelhä and R. Peltonen*

Self-organizing representations, *Teuvo Kohonen*

Quasiclassical theory of the elementary pinning potential of a vortex line to a small defect in a type II superconductor, *J. Kurkijärvi, D. Rainer, and E. V. Thuneberg*

On-line determination of vertical distribution of filler materials in paper using X-ray techniques, *Juhani Kuusi and Heikki Kumpulainen*

Electroreflectance and crystal structure of thin zinc sulfide films, *J. A. Lahtinen and T. Tuomi*

Thermal microscopes, *Mauri Luukkala*

A study of an optimum investment policy during balanced expansion of supply, *Pentti Malaska*

Regional optimization model for Finnish energy economy, *Marke Mannonen, Jyrki Myllyvirta, Pekka Pirilä, and Jorma Routti*

Magnetic field and forces of a high intensity permanent magnet separator, *Tor Meinander*

Ceramization of nuclear wastes with clay, *Jorma K. Miettinen and Jukka Lehto*

Tracer analysis and modelling of industrial ore grinding system, *Antti J. Niemi*

Large-scale applications of dilution refrigerators, *T. O. Niinikoski*

On the optimization of the operation of tidal power plants: application of the back-and-forth shooting method, *P. Jussi Orava and Timo J. Eirola*

Assessment of flaw detection probability in the case of pressure vessel materials, *Harri Riikonen, Jarmo Raussi, and Olli J. A. Tiainen*

Coupled oscillator models of ring laser gyros, *Stig Stenholm*

Modification of the surface due to ion bombardment: an XPS study, *F. Werfel and E. Suoninen*

APPENDIX B

ACTA POLYTECHNICA SCANDINAVICA EI 50, 'Helsinki International Summer School on Semiconductors 1982'

CONTENTS

Preface, *Tor Stubb*

Physics of small devices, *J. R. Barker*

Non-crystalline semiconductors, *H. Fritzsche*

Dynamical conductivity and dielectric function of general semiconductors and of magnetic semiconductors, *P. Grosse*

Hot carrier physics and higher order electron phonon dynamics, *P. Kocevar*

Strong electronic correlations in magnetic semiconductors: the functional integral approach to the Hubbard model, *P. Leroux Hugon and D. Paquet*

Small device technology — dielectric semiconductors systems, *T. Sugano*

Electronic transport in tetrahedral amorphous semiconductors, *P. Thomas*

Magnetic ordering phenomena in rare earth semiconductors, *W. Zinn*

List of participants

ACTA POLYTECHNICA SCANDINAVICA

...a Scandinavian contribution to international engineering sciences

1958—1971 published under the auspices of the Scandinavian Council for Applied Research

in *Denmark* by the Danish Academy of Technical Sciences

in *Finland* by the Finnish Academy of Technical Sciences, the Swedish Academy of Engineering Sciences in Finland and the State Institute for Technical Research

in *Norway* by the Norwegian Academy of Technical Science

in *Sweden* by the Royal Swedish Academy of Engineering Sciences

As of 1972 the journal is published by the Finnish Academy of Technical Sciences. The Editor-in-Chief is Professor Mauri Luukkala and the editorial secretary is Ari Rautsara.

Acta Polytechnica Scandinavica is divided into the following sub-series:

Annual subscription

Chemical Technology and Metallurgy Series, Ch
editor Professor Seppo Palosaari

Fmk 100.00

Civil Engineering and Building Construction Series, Ci
editor Professor Jussi Hyyppä

Fmk 100.00

Electrical Engineering Series, El
editor Professor Seppo Halme

Fmk 100.00

Mathematics and Computer Science Series, Ma
editor Professor Reijo Sulonen

Fmk 100.00

Mechanical Engineering Series, Me
editor Professor Matti Ranta

Fmk 100.00

Applied Physics Series, Ph
editor Professor Mauri Luukkala

Fmk 100.00

Subscriptions may be entered for the complete series or for one or more of the subseries. In addition single copies may be purchased through booksellers or directly from the publisher.

Backfile issues are also available on 35 mm microfilm from University Microfilm International, 300 North Zeeb Road, Ann Arbor, Michigan 48106, USA.

THE FINNISH ACADEMY OF TECHNICAL SCIENCES

Kansakoulukatu 10 A, 00100 Helsinki 10, Finland

